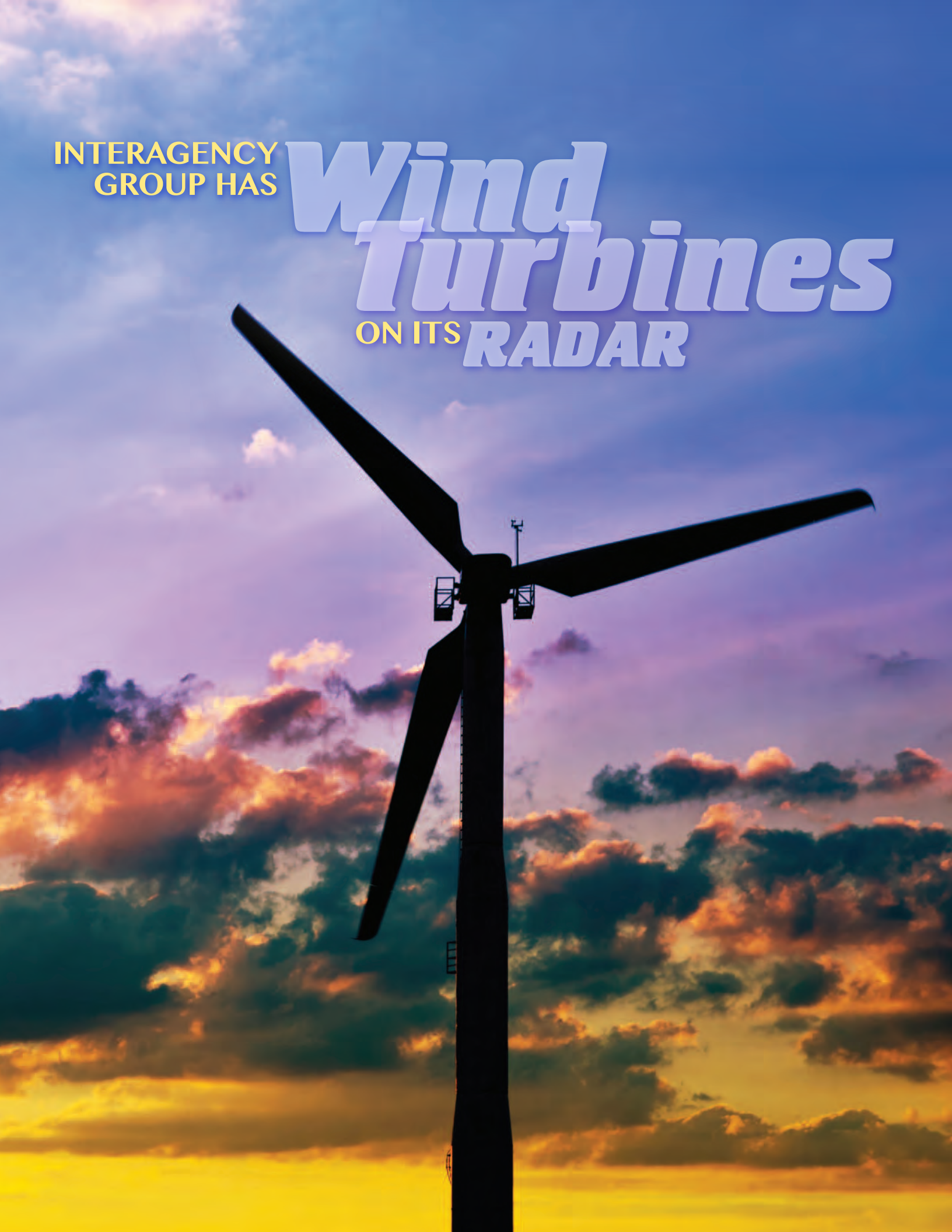
Wind Turbine Radar Interference Mitigation Work Group Aims to Assess & Mitigate Radar Impacts

The interagency Wind Turbine Radar Interference Mitigation (WTRIM) work group is addressing potential wind turbine interference with federal (including Navy) radar systems by identifying effective mitigations to this complex issue through research and development, coordination, and outreach.

Over the past few years, the country's energy portfolio has rapidly diversified with renewable energy generation, including solar, wind, and geothermal becoming increasingly mainstream. According to the U.S. Department of Energy, renewable energy accounted for approximately 13.5 percent of energy generation in the United States in 2014. But as renewable energy generation increases, in particular from wind, land and airspace use, challenges are becoming more apparent.

The best locations for wind turbines often coincide with areas that are optimal for radar and flight operations conducted by the military—reasons being their remoteness, topography, and weather. Consequently, wind energy development presents unique challenges to several federal agencies including the Department of Defense (DoD).


INTERAGENCY GROUP HAS
Wind Turbines
ON ITS RADAR

The best locations for wind turbines often coincide with areas that are optimal for radar & flight operations conducted by the military.

Wind turbines located near or adjacent to radars or under certain types of air space can cause adverse impacts. Turbines can reach heights of over 400 feet, which can cause physical obstruction and pose safety hazards to aircraft during take-off or landing. Secondly, turbines can potentially affect the quality of communication systems and impact air navigation systems. Finally, turbines can interfere with military, weather, and air traffic control radars. Electromagnetic interference with radar is the most complicated and the most costly of these impacts to address, and is the reason that the WTRIM work group was formed.

Naval Station Guantanamo Bay, Cuba. Often locations that are optimal for wind energy development share characteristics that make them ideal for military radar operations, such as topography and weather.
Chief Mass Communication Specialist Bill Mesta

About Radar

Radar works much like echolocation in bats. The transmitter emits pulses of microwaves, which are broadcast by an antenna. When these waves encounter an object, the radar system calculates the size and distance of the object.

The most prevalent form of radar in use today is Doppler radar. The "Doppler Effect" tracks the microwave signal reflected off a moving object and analyzes how its motion has altered the frequency or phase of the returned signal over time. This determines the object's velocity. (This is how police radar detects speeding.) Doppler radar is also used by:

1. The Federal Aviation Administration (FAA) for air traffic control.
2. The National Oceanic and Atmospheric Administration (NOAA) to track weather patterns.
3. The Department of Homeland Security (DHS) for border and national airspace surveillance.
4. The DoD to track hostile, unidentified, and friendly targets in the air, on land and at sea.

Radar interference from wind turbines can create the appearance of false targets—making it harder to identify hostile aircraft and potentially endanger air crews.
MC3 Kasey Krall

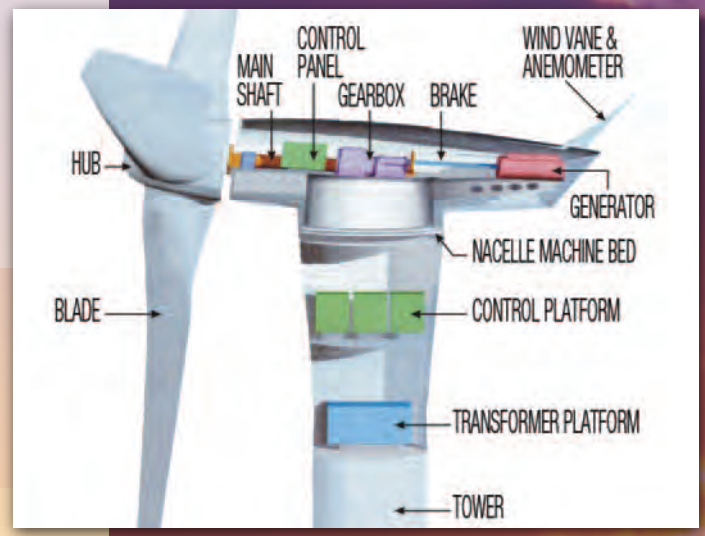
Interference with Doppler Radar

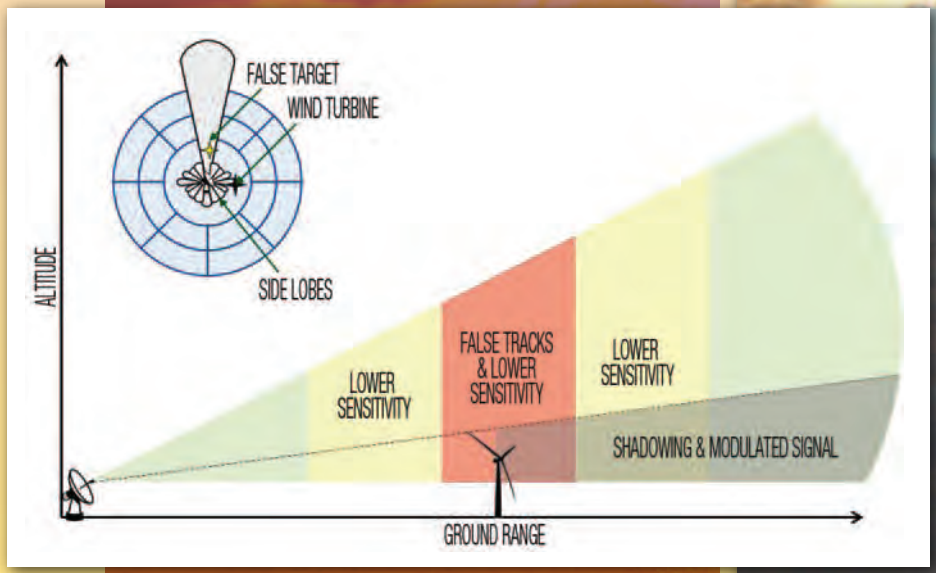
A wind turbine hub rotates 360 degrees. A typical turbine with 200-foot-long blades moves around the hub very quickly. At an optimal wind speed for generating energy, the hub will rotate at roughly 14 revolutions per minute, which translates to the

The Problems with Turbines

The problems with wind turbines is that they can:

1. Cause physical obstruction and pose safety hazards to aircraft during take-off or landing.
2. Affect the quality of communication systems and impact air navigation systems.
3. Interfere with military, weather, and air traffic control radars.





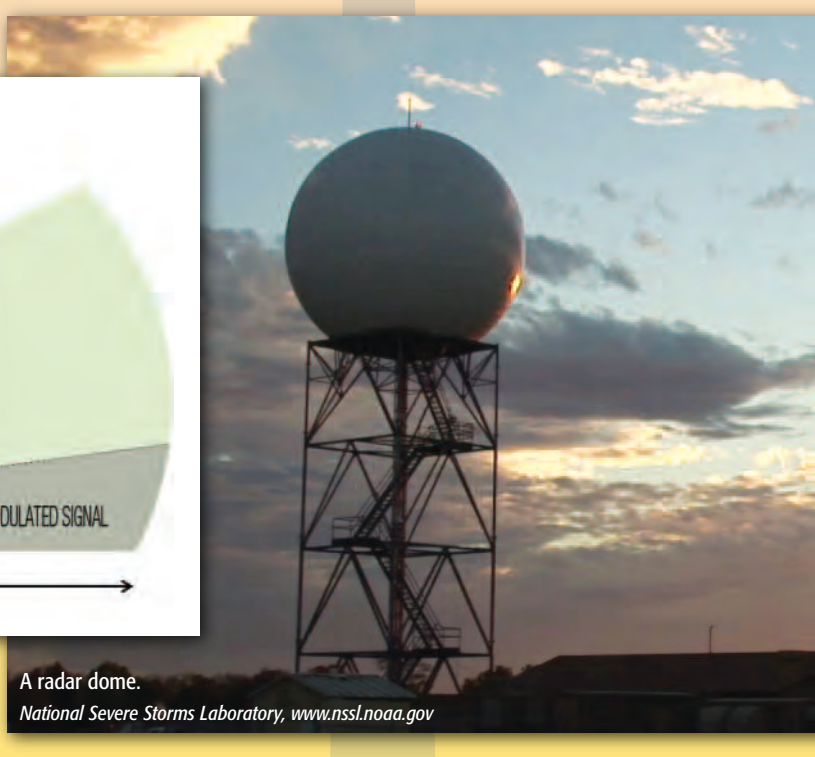
tip of the blade rotating up to 225 miles per hour—the speed of a small aircraft. Depending on the angle of the turbine to the radar receiver, each blade tip has the potential of being detected. The angle of the turbine determines the type of false target on the radar screen, such as a target traveling towards the radar, going away from the radar, or crossing the radar screen.

Complicating the issue is the fact that turbines are generally grouped together, which can lead to cumulative effects. As a result, the impact from a group of turbines, each with three rotating blades, can quickly burden a radar system with thousands of false targets.

A real target, such as an enemy aircraft, can be easily lost in what appears as a blizzard of false targets. This is of particular concern for DoD when conducting radar-dependent test and training activities or missions.

An Interagency Solution to an Interagency Problem

In 2012, four federal agencies, the Department of Energy (DOE), DoD, DHS, and the FAA, pooled resources to conduct three complex field tests that measured the impact of wind turbines on Doppler air surveillance radars and to test the ability of private sector technologies to mitigate such interference.



A radar dome.
National Severe Storms Laboratory, www.nssl.noaa.gov

The results of the IFT&E program indicated the impact of wind turbine interference on the three radar types was significant.

Rotating wind turbine blades can cause several adverse impacts to military operations, including physical obstruction to aircraft, electromagnetic interference, and interference with radars.
Airman 1st Class Amber Carter

Wind turbines at U.S. Naval Station Guantanamo Bay are 80 meters (262 feet) high and provide energy for the naval station and Joint Task Force Guantanamo.
Kathleen T. Rhem

The two-year effort was known as the Interagency Field Test & Evaluation (IFT&E) program. Each field test was conducted close to an existing Doppler radar where a large number of wind turbines were in view. In total, the study assessed three impacted radars and eight potential industry mitigation solutions.

The results of the IFT&E program indicated the impact of wind turbine interference on the three radar types was significant. In areas where wind turbines were not present, all radars demonstrated the ability to meet or exceed their detection requirements. However, target detection in regions over and near wind turbines suffered a notable drop in maintaining a real target, and an associated rise in false detection reports.

While several mitigation technologies tested showed promise, they were not fully mature, and required additional development and testing, including the need to address deployment and integration. The IFT&E program demonstrated that federal agencies, with seemingly disparate missions, could successfully collaborate. To continue the IFT&E's momentum, the WTRIM work group was established in 2014.

Member agencies include the IFT&E participants: DoD, DOE, NOAA, and FAA. DHS and the Department of Interior (DOI) also participate as observers.

WTRIM-funded Research & Development Efforts

Co-funding an enhanced version of the U.S. Geological Survey (USGS) wind turbine database, USGS developed a publicly available data set to track wind turbine locations. WTRIM member agencies and industry stakeholders would benefit from having access to enhanced and up-to-date data from a common wind turbine database. The existing USGS data set is available at www2.usgs.gov/blogs/features/usgs_top_story/mapping-the-nations-wind-turbines.

Pilot Mitigation Project at Travis Air Force Base

This project was formed to provide a mechanism for government to partner with industry to facilitate both wind energy development and the long-term on-site testing of mitigation solutions, including a class of new radar systems with advanced clutter detection capabilities known as "in-fill" radar. A number of these systems were tested under the IFT&E program; this project would set standards for employing these systems in the future.

Radar Obstruction Evaluation Model/Simulator (ROEMS) Upgrade

ROEMS is a 3D radar modeling tool originally developed for NORAD to support radar performance evaluations and operational mission impact analysis. The WTRIM work group has supported upgrading the tool and making it more available to federal agencies that have a modeling and simulation program. Analytical Graphics, Inc. completed and recently delivered the upgraded tool, now called ROEMS II, to NORAD.

Ground-Based Coastal Air Surveillance Radar Wind Turbine Radar Interference Vulnerability Study

MIT LL will assess geographic areas and associated coastal air surveillance radars that may be impacted by offshore wind turbines. The study will characterize coastal radar clutter environments before and after the installation of offshore wind turbines. Using the data collected, the study will assess how well current mitigation technologies will perform compared to land-based wind turbine settings and will recommend new mitigation technologies specifically tailored for offshore issues. Additionally, the study will identify shortfalls and recommend improvements to current wind turbine radar interference modeling and simulation tools such as ROEMS II.

Since these agencies rely on Doppler radar, they are susceptible to degraded radar performance due to wind turbine interference. Additionally, these agencies' radars are frequently inter-linked to maximize their coverage zone (ranging from a region to a continent).

Other Participants

In addition, a diverse number of other stakeholder organizations participate in the WTRIM work group, including representatives from the military (e.g., Coast Guard and North American Aerospace Defense Command (NORAD)); federal agencies (e.g., Bureau of Ocean Energy Management; the DOD/DHS inter-Department Long Range Radar Joint Program Office). Further, several national laboratories such as Sandia National Laboratories and the Massachusetts Institute of Technology Lincoln Laboratory (MIT LL) are important contributors to helping the WTRIM work group identify, design, and test various approaches to mitigating wind turbine induced interference.

The WTRIM work group focuses on mitigating the technical and operational impacts of wind turbine projects on various federal radar missions. To achieve this objective the group set two goals. First was to pursue and develop technical mitigation solutions by identifying the "low-hanging fruit" that could serve as an interim fix until more advanced technical solutions could be developed, tested, and deployed.

A radar dome.

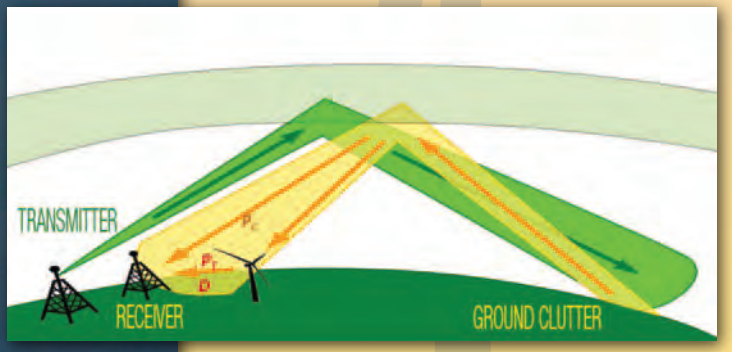
The WTRIM work group focuses on mitigating the technical & operational impacts of wind turbine projects on various federal radar missions.

The wind turbines on top of John Paul Jones Hill have been fully operational at Naval Station Guantanamo Bay, Cuba since July 2005.
Spc. Megan Burnham

These solutions, while primarily technology-driven, can also include policy and legislative approaches. The second goal is for the WTRIM member agencies to determine funding requirements and levels of contribution to develop and make solutions available.

To that end, WTRIM work group member agencies collectively fund research and development projects to identify issues and solutions to assess, manage, or prevent interference. In 2015, DoD, DOE, and FAA agreed to a robust integrated research and development budget plan to develop and field effective radar mitigation solutions. For fiscal years 2016 and 2017, this amount totals $3.9 million. The intent of the plan is to address the following strategic themes:

1. Improve the capacity of government and industry to evaluate the impacts of wind energy installations on sensitive radar systems.
2. Develop and facilitate the deployment of mitigation measures to increase the resilience of existing radar systems to wind turbines.
3. Encourage the development of next-generation radar systems that are resistant to wind turbine radar interference.



The ROTHR works by bouncing signals off the ionosphere. The system is comprised of a transmitter and receiver. The WTRIM work group is involved in a study to verify the efficacy of an MIT LL-developed model to predict effects of wind turbines on this unique radar system.
MIT/Lincoln Laboratories

A Closer Look at Impacts to Navy Radar

For the past three years, the WTRIM work group has been involved with a study assessing the efficacy of an existing MIT LL model to protect the Navy-owned and operated Relocatable Over-the-Horizon Radar (ROTHR). The ROTHR provides wide-area air and sea surveillance to military and law enforcement agencies. More specifically, ROTHR supports the U.S. Southern Command's drug interdiction mission. There are three ROTHR systems in the U.S.—two are located in Texas, one in North Carolina, and another in Puerto Rico. Due to the abundance of wind resources near these sites, all are increasingly threatened by wind turbine projects. The radar's unique use of the ionosphere to obtain extremely long-range tracking of suspect targets makes it highly vulnerable to electromagnetic interference emanating from wind turbines.

The MIT LL-developed model predicted the impact of the new wind turbine projects would not exceed acceptable limits of interference on the ROTHR systems if wind developers agree to certain limitations, such as altering a project's site layout and reducing the number of turbines. Based on the MIT LL model, DoD reached several agreements with wind developers whose proposed projects could potentially impact the ROTHR systems. Following the installation of each turbine, the developer will conduct tests for each turbine and associated equipment to gauge impacts on the ROTHR. Mechanisms to address radar impacts, should they occur in the future, include provisions to temporarily lock wind turbine blades from rotating. This current study, largely funded by the DoD Siting Clearinghouse (SCH), is essentially evaluating the accuracy of the MIT LL model.

As the nation's energy portfolio continues to shift toward renewable sources, proactive efforts like the WTRIM work group will be critical, not only in preserving vital military and other federal agency mission capabilities, but also in safeguarding the country's investment in radar systems.

To learn more about the WTRIM work group, visit http://energy.gov/sites/prod/files/2016/06/f32/Federal-Interagency-Wind-Turbine-Radar-Interference-Mitigation-Strategy-02092016rev.pdf.

Lou Husser
Office of the Secretary of Defense
Director, Operational Test & Evaluation
571-372-3849
louis.a.husser.ctr@mail.mil

DoD on the WTRIM

The DoD SCH is the DoD representative on the WTRIM work group. The DoD SCH was formally established in 2011 to coordinate the review and assessment of impacts of wind, solar, transmission line, and other projects to military activities. As in the case of the Navy ROTHR, the DoD SCH is able to identify feasible and affordable long-term actions, including funding research and development and signing mitigation agreements with developers to address adverse mission impacts resulting from wind turbines.

Wind energy will continue to play an important role in our nation's energy portfolio.
—Ron Tickle

"Wind energy will continue to play an important role in our nation's energy portfolio; therefore, it is critical DoD remain engaged with other Federal agencies and the private sector to further understand issues and identify solutions," explained Ron Tickle, Director of the DoD SCH. "The interagency nature of the WTRIM work group provides DoD with a holistic view when assessing and mitigating potential impacts. Understanding the different agencies' missions and goals leads to more collaborative solutions to the complex, and often project-specific issues resulting from wind turbine interference."

To learn more about the DoD Siting Clearinghouse, visit www.acq.osd.mil/dodsc.